

PORCELLANID CRABS FROM GOA, EASTERN ARABIAN SEA  
(CRUSTACEA: DECAPODA: PORCELLANIDAE)

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We report here 10 species of Porcellanidae sampled along the coast of Goa, India, each of which is described and figured. *Polyonyx splendidus* is registered for the first time outside the type region, and *Petrolisthes coccineus* is registered for the first time for the Arabian Sea. Accordingly, the porcellanid fauna of the western coast of the Indian subcontinent now consists of 16 species, including two endemics, *Polyonyx hendersoni* and *P. splendidus*. For the Indian Ocean, 9 species are here reported as endemic. We provide a key for the identification of all species so far reported for the western coast of the Indian subcontinent.

**Key words:** Crustacea, Anomura, Porcellanidae, Goa, Arabian Sea, taxonomy, biogeography

## INTRODUCTION

The Porcellanid fauna of the coast of Goa remains unknown despite earlier studies conducted at different locations of the East Arabian Sea. e.g. Ratnagiri (Sankolli 1963a,b, 1966), along the west coast of India and coast of Pakistan (Tirmizi *et al.* 1982, 1989). Towards the goal of studying the occurrence, habitat and distribution of the species on the coast of Goa, we conducted fieldwork in the rocky region of Bogmolo in the vicinity of Marmugoa harbour, including St. George Island, and of Anjuna for ten days in December 2006.

## MATERIAL AND METHODS

Crabs were collected during low tide by snorkelling and scuba diving up to 12 m depth, and preserved in 75% ethanol. Collected specimens were brought to the National Institute of Oceanography (NIO), Biological Oceanography Division, Dona-Paula, Goa, for identification. For each species we included: (1) the taxonomic history including a list of synonyms, (2) number and sex of specimens collected, (3) habitat characteristics and distribution, and (4) a scientific drawing of habitus (using a camera lucida). This information is followed by a taxonomic key to the species of the western coast of the Indian subcontinent.

## RESULTS

### Systematic account

*Ancylocheles gravelei* (Sankolli, 1963) (Fig. 1)  
*Pachycheles* sp.: Gravely, 1927: 140, pl.20, fig.9.

*Porcellana gravelei*: Sankolli, 1963a: 280, fig.1; Sankolli, 1966: 304, fig.5; Haig, 1965: 108; Haig, 1972: 447  
*Ancylocheles gravelei*: Haig, 1978: 777; Haig, 1981: 275; Tirmizi, *et al.*, 1982: 4 (key), fig.11; Tirmizi *et al.*, 1989: 35, fig.22; Morgan, 1990: 28

**Material examined:** 4♂, 5♀, Bogmolo Beach, St. George Island, under rocks, mid-tide, 0.5 m.

**Description:** Carapace about as long as broad, subquadrate. Dorsal surface smooth, laterally slightly rugose, anterior regions well-marked. No epibranchial spine. Front broad, sinuously transversal or evenly rounded. Orbits moderately deep, inner orbital angle produced into rounded edge, outer orbital angle produced into small tooth.

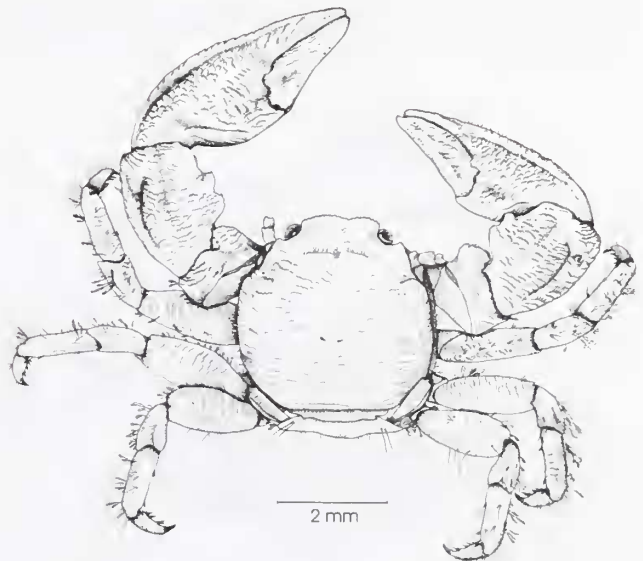


Fig. 1: *Ancylocheles gravelei* (Sankolli, 1963), male, Goa, Bogmolo, St. George Island

Eyes moderately large. Movable segments of antennae granulous without larger projections.

Chelipeds subequal; merus with a large, denticulate lobe at antero-proximal edge, carpus about 1½ times as long as broad, anterior margin with two large teeth on proximal half; dorsal surface granular with two longitudinal crests, outer border strongly convex; palm granular with a broad longitudinal ridge, extending onto pollex, outer border convex or distally nearly straight.

Walking legs slender, moderately granular with scattered, simple setae, dactylus with four movable spinules on inner border.

**Habitat:** The species is abundant in the lower intertidal area, and inhabits interstices of stones and rubble overgrown by sponges and other fouling organisms.

**Distribution:** *A. gravelei* shows a disjunctive distribution in the Indian Ocean, and is known from Pakistan, the western Indian coast and West Australia.

***Enosteoides ornatus* (Stimpson, 1858) (Fig. 2)**

*Porcellana ornata*: Stimpson, 1858: 242; Stimpson, 1907: 188; Gordon, 1931: 526, 529, fig.1; Miyake, 1943: 118, figs.42, 43; Sankolli, 1966: 302, fig.4; Kim & Choe, 1968: 1, pl.1, fig.1, fig.1; Morton & Morton, 1983: 272, 274, 299, figs.12.9: 4, 12.20: 3

*Porcellana corallicola*: Haswell, 1882: 759; Johnson, 1970: 32, figs.3q, r

*Petrolisthes corallicola*: Miers, 1884: 271, pl.29, fig.c

*Enosteoides ornatus*: Haig, 1978: 709; Haig, 1981: 271; Markham, 1982: 329; Tirmizi *et al.*, 1982: 4; Tirmizi *et al.*, 1989: 37, fig.23; Haig, 1992: 305, fig.2; Yang & Sun, 1992: 209, fig.15; Yang & Naiyanetr, 1997: 9, fig.5; Hsieh *et al.*, 1998: 335, figs.32b, 33; Komai, 2000: 361

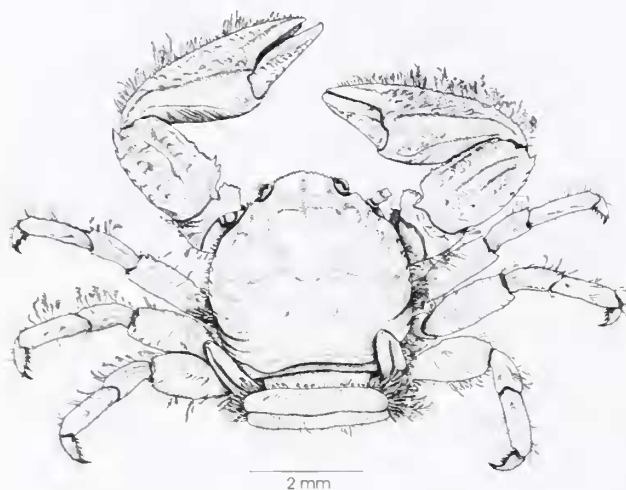


Fig. 2: *Enosteoides ornatus* (Stimpson, 1858), female, Bogmolo, St. George Island, Goa

**Material examined:** 1 ♂, 2 ♀, Anjuna Beach, 1.0-1.5 m, under rocks; 8 ♂, 10 ♀, Bogmolo Beach, St. George Island, 5 m, under rocks.

**Description:** Carapace as long as broad, ovate, epibranchial edges slightly pronounced, rounded. Dorsal surface uneven, granular; regions well-defined. Front projecting beyond eyes, triangular in dorsal view, denticulate. Orbits moderately deep, outer orbital angle weakly pronounced. Side walls covered with long, plumose setation. Eyes small. First and second movable segments of antenna short, granulate, third one simple.

Chelipeds robust, subequal in size; merus with prominent, denticulate lobe at antero-proximal edge; carpus about 2 times as long as broad, anterior border denticulate, proximally forming irregular sharp tooth; dorsal surface with three longitudinal crests, outer margin with a row of sharp teeth, the distal one forming a spine-tipped prominent edge; surface of palms with longitudinal crest, outer margin spinulated, with a fringe of long feathered setae.

Walking legs slender, covered with scattered, long, feathered setae; carpus of leg 1 with antero-distal spine; dactylus with five movable spines.

**Habitat:** Haig (1981) reported the species from the intertidal area under stones, and on coral heads to 54 m depth. We found the species sporadically on the coast of Goa from the lower intertidal to 8 m depth.

**Distribution:** The species is known from Pakistan and the western Indian coast, eastward through the Bay of Bengal, and from West Australia. In the western Pacific, the species has been reported from the Gulf of Thailand through the South China Sea, Taiwan Strait and southern Japan, and from eastern Australia.

***Pachycheles natalensis* (Krauss, 1843) (Fig. 3)**

*Porcellana natalensis*: Krauss, 1843: 58, pl.4, figs.1, 1a-c; Stimpson 1858: 228

*Pisosoma natalensis*: Paul'son, 1875: 88, pl.11, fig.5; (English translation, 1961: 94, pl.11, fig.5)

*Pachycheles sculptus*: Ortmann, 1894: 29; Nobili, 1906a: 136; Nobili, 1906b: 67

*Pachycheles natalensis*: Stimpson, 1907: 186; Riddell, 1911: 263; Balss, 1915: 8; Ramadan, 1936: 25; Barnard, 1950: 472, figs. 87a-f; Barnard, 1955: 4; Haig, 1964: 371; Haig, 1966a: 286 (key), 289; Haig, 1966b: 43; Haig, 1966c: 53; Sankolli, 1966: 300, fig.3; Lewinsohn, 1969: 150, fig.33; Lewinsohn, 1979: 50; Tirmizi *et al.*, 1982: 2 (key), fig.1, pl.1; Tirmizi *et al.*, 1989: 4, figs.1, 2; Werdning & Hiller, 2007: 4, fig.3

*Pisosoma sculpta*: Gravely, 1927: 124, pl.20, fig.8

**Material examined:** 3 ♂, 4 ♀, Anjuna Beach, 1.0-1.5 m,

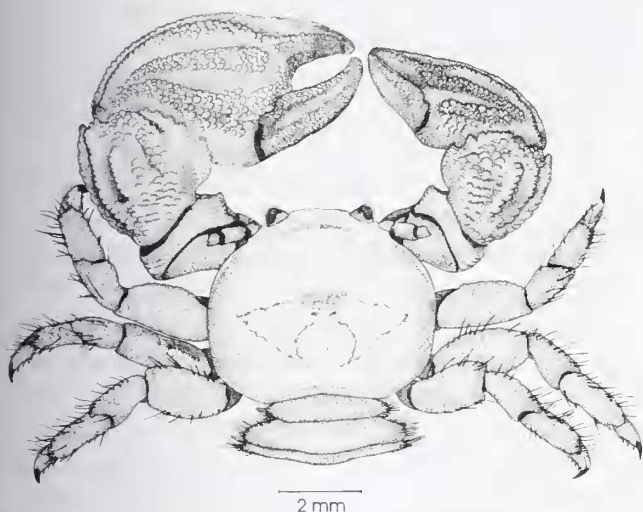


Fig. 3: *Pachycheles natalensis* (Krauss, 1843), male, Red Sea, Egypt (from Werding & Hiller, 2007)

mid-low tide, under rocks; 6♂, 6♀. Bogmolo Beach, low tide, under rocks.

**Description:** Carapace generally somewhat broader than long, subovate, convex. Dorsal surface smooth, regions poorly defined. Front inclined, rounded from above or moderately trilobate. Orbits well-defined, outer orbital angle forming a blunt tooth. Lateral walls formed by anterior trapezoid plate covering two thirds of wall, another large, subquadrate plate covering posterior area.

Eyes medium-sized. First movable segment of antenna with conical tubercle; second and third somewhat granulated; flagellum 1½ as long as carapace, sparsely setose.

Chelipeds large, robust, different in size, surface of carpus and manus nearly smooth or covered with large granules arranged in three longitudinal crests in carpus, and forming two similar crests along outer margin of chela; carpus about as long as broad or barely longer, anterior border with three or four teeth decreasing in size distally; outer margin of palm convex, fingers gaping in major cheliped, usually with tuft of setae in gape of larger chela, meeting for entire length in minor cheliped. Walking legs stubby, moderately granulated and with scattered, simple setae; dactylus with three movable spines.

Telson five-plated; males with a pair of pleopods.

**Habitat:** The species was found regularly in the deeper intertidal zone inhabiting interstices of stones and rubble held together by sponges.

**Distribution:** *P. natalensis* is restricted to the western Indian Ocean, including the Red Sea, along the coast of the Arabian Sea. On the African coast it is distributed southward to Mozambique including Madagascar.

***Petrolisthes boscii* (Audouin, 1826) (Fig. 4)**

*Porcellana boscii*: Audouin, 1826: 89; Heller, 1861a: 24; Heller, 1861b: 256

*Petrolisthes boscii*: Stimpson, 1858: 227; Paul'son, 1875: 87, 88; Henderson, 1893: 427; Ortmann, 1897: 284; McCulloch, 1913: 353, fig.53; Balss, 1913: 29, pl.1, fig.4; Balss, 1915: 7; Gravelly, 1927: 140; Hale, 1929: 68; Ramadan, 1936: 24; Miyake, 1937: 211, fig. 1, pl.12, fig.2; Miyake, 1943: 90, figs.23, 24; Vatova, 1943: 15; Haig, 1964: 360; Haig, 1965: 99; Sankolli, 1966: 296, fig.1; Haig, 1966c: 51; Sarojini & Nagabhushanam, 1968: 153, pl.1, fig.3; Lewinsohn, 1969: 132, figs.27a-e; Johnson, 1970: 13; Nakasone & Miyake, 1971: 8; Mustaquim, 1972: 154, fig.2; Ahmed & Mustaquim, 1974: 174; Hogarth, 1988: 1101; Tirmizi *et al.*, 1982: 2, fig.3; Tirmizi *et al.*, 1989: 10, figs.5a-h; Haig, 1992: 312, figs.8a-c; Yang & Sun, 1992: 197, figs.2a-c, 3a-e; Yang & Naiyanetr, 1997: 5; Komai, 2000: 364; Werding & Hiller, 2007: 7, 8, fig.5

*Petrolisthes amakusensis*: Miyake & Nakasone, 1943: 173, figs.1-3

*Petrolisthes rugosus*: Miers, 1884: 270

*Porcellana (Petrolisthes) boscii*: de Man, 1888: 217

**Material examined:** 12♂, 15♀, Bogmolo Beach, under rocks, low-tide; 1♂, 1♀, Bogmolo Beach, St. George Island, 5 m, under rocks; 2♂, 2♀, Anjuna Beach (North), under rocks, 1.0-1.5 m, low tide.

**Description:** Carapace slightly longer than broad, inversely cordate, evenly rounded along branchial margins; surface with inconspicuous, interrupted transverse, plications; one epibranchial spine present. Front sinuously triangular with longitudinal depression; orbitae shallow, without supraocular spine, postorbital angle rectangular, without tooth. Eyes

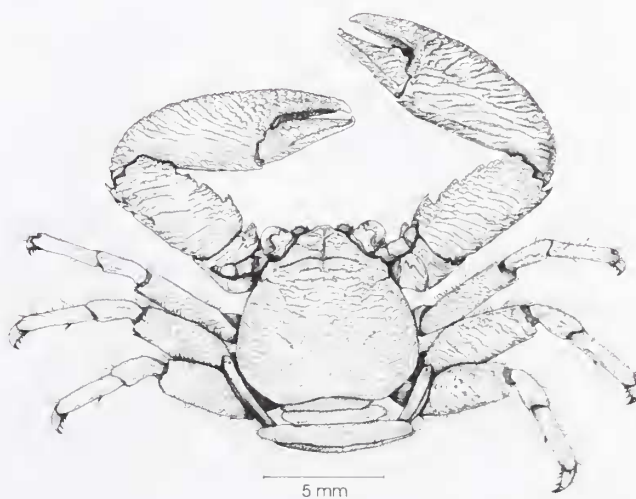


Fig. 4: *Petrolisthes boscii* (Audouin, 1826), male, Bogmolo, St. George Island, Goa

moderately large. Basal segments of antennulae with some transverse rugae, anterior margin with teeth. First movable segment of antennae with serrated, spine-tipped lamellar lobe; second and third segments slightly rugose.

Chelipeds subequal, surface with piliferous striations, merus rugose with serrated lobe on anterior margin; carpus two times as long as broad, armed on anterior margin with two or three broad, serrated teeth proximally, the first one spine-tipped; posterior margin slightly convex, armed distally with a strong spine, followed by two smaller ones. Chelae broad, with transverse striations, outer margin evenly rounded, spineless.

Walking legs rugose; all segments with irregularly wide-set, feathered and simple setae; Merus spineless with an exception of a small posterodistal spine on legs 1 and 2, carpus spineless; propodus with terminal triplet of movable spines on ventral border and an additional one at mid level; dactylus large with three movable spinules on inner border.

**Habitat:** Lewinsohn (1969) reported *P. boscii* from shallow water to 18.3 m depth, from rocks, boulders and corals. We found it among boulders in the deeper intertidal and the subtidal, where it appears to be the most abundant porcellanid species.

**Distribution:** West Indian Ocean, including the Red Sea, and along the coast of the Arabian Sea through the Bay of Bengal. In the Pacific from the Gulf of Thailand, Indonesia and Japan. Also in tropical Australia.

***Petrolisthes coccineus* (Richardson *et al.*, 1839) (Fig. 5)**

*Porcellana coccinea*: Richardson *et al.*, 1839: 87, pl.26, figs.1, 2; Dana, 1852-53: 423

*Petrolisthes coccineus*: Laurie, 1926: 14; Miyake, 1943: 59, figs.3, 4; Haig, 1966b: 46, (key); Kensley, 1970: 114,

fig.8; Haig, 1983: 280; Haig, 1992: 313, fig.9; Hsieh *et al.*, 1998: 303, fig.16; Yang & Sun, 1990: 3, pl.3

*Petrolisthes barbatus*: de Man, 1893: 296, pl.7, figs.4, 4a; Ortmann, 1894: 28; Ward, 1942: 63

*Petrolisthes pubescens*: Balss, 1913: 30, pl.1 fig.2

*Petrolisthes nipponensis*: Miyake, 1937: 213, fig.22, pl.12 fig.1

**Material examined:** 3♂, 2 juv. Bogmolo Beach, under rocks, low tide.

**Description:** Carapace slightly longer than broad, evenly rounded along branchial margins, inversely cordate. Surface with faint, transverse plications on cardiac region and along posterior lateral margins; one epibranchial spine present. Front narrow, sinuously triangular with longitudinal depression; orbitae shallow, supraocular spine strong, postorbital angle blunt. Eyes large. Basal segment of antennulae with some transverse rugae, anterior margin with teeth. First movable segment of antennae with serrated, spine-tipped, lamellar lobe; second produced forwardly, forming a serrated, edged tooth; third segment slightly rugose.

Chelipeds subequal, merus rugose with spine-tipped projection on anterior margin; distal border with a pair of spines, a third one upon surface; carpus about two-and-a-half times as long as broad; surface with two rows of scale-like, flattened granules, one forming a shallow longitudinal crest along midline, the second along posterior margin; anterior margin with three serrated spine-tipped teeth; posterior margin slightly concave, distal edge armed with a pair of strong spines, followed by two weaker ones. Chelae flat, surface with a row of granules forming a longitudinal ridge; area towards outer margin with scattered granules and scattered, feathered setae. Outer border with a row of strong, spine-tipped teeth.

Walking legs rugose, with scattered, simple, feathered setae; anterior margin of merus with a row of strong spines; a pair of large posterodistal spines on merus of legs 1 and 2, a smaller one on leg 3; carpus of leg 1 with anterodistal spine; propodus with terminal triplet of movable spines on ventral border, with one or two, additional ones; dactylus large with three movable spinules on inner border.

**Habitat:** Haig (1983) reported the species from shallow water to 1.2 m in the Seychelles. According to Miyake (1943), the species occurs between tide marks under rocks. We found few specimens in two locations under large boulders.

**Distribution:** *P. coccineus* shows an extremely large distributional range from the coast of Mozambique through scattered locations in the Indian Ocean, and the western Pacific to the Easter Island. Its occurrence on small and distant oceanic islands is remarkable. In the Indian Ocean, it is reported from the Seychelles, Chagos Archipelago and Nicobar

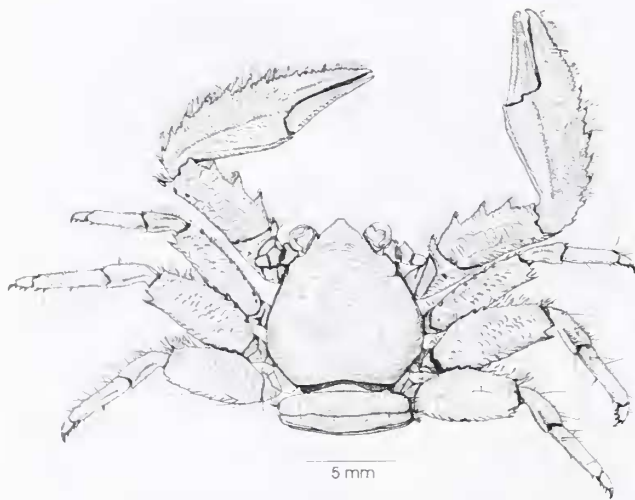


Fig. 5: *Petrolisthes coccineus* (Richardson *et al.*, 1839), male, Bogmolo, St. George Island, Goa

Islands; in the Pacific from Ogasawara, the Mariana Islands, Hawaii, the Tuamotu Archipelago and Easter Island. Additionally, it has been reported from Indonesia and Taiwan. The finding from India is the first record from continental Asia.

***Petrolisthes lamarckii* (Leach, 1820) (Fig. 6)**

*Pisidia lamarckii*: Leach, 1820: 54

*Petrolisthes lamarckii*: Stimpson, 1858: 227; Miers, 1884: 557; Stimpson, 1907, pl.22 fig.2; Ortmann, 1894: 26; Borradaile, 1898: 464; Miyake, 1942: 342, figs.7, 8; Miyake, 1943: 98, fig.29; Barnard, 1950: 477 figs.89 a-d; Haig, 1964: 362; Haig, 1966b: 47; Mustaquim, 1972: 154, fig.3; Haig, 1979: 124; Haig, 1983: 283; Kropp, 1983: 100; Yang, 1983: 3, pl.4; Tirmizi *et al.*, 1982: 10, fig.4; Hogarth, 1988: 1101; Tirmizi *et al.*, 1989: 12, figs.7, 8; Haig, 1992: 315, fig.11; Hsieh *et al.*, 1998: 326, fig.28

*Petrolisthes lamarckii*: Doflein & Balss, 1913: 162

*Petrolisthes lamarckii*: Laurie, 1926: 140; Taylor, 1968: 170

*Porcellana dentate*: H. Milne Edwards, 1837: 252

*Porcellana pulchripes*: White, 1847: 129

*Porcellana speciosa*: Dana, 1852-53: 417; Dana, 1855: pl.26, fig.8; Balss, 1913: 30 *Petrolisthes dentatus*: Rathbun, 1910: 314

*Porcellana bellis*: Heller, 1865: 76.

**Material examined:** 4♂, 3♀ Anjuna Beach, intertidal;

2♀, Anjuna Beach, intertidal; 14♂, 20♀, Bogmolo Beach, under rocks, intertidal 1 m.

**Description:** Carapace about as long as broad, ovate, weakly convex front to back and transversely, lateral margins evenly rounded. Dorsal surface slightly rugose, regions moderately marked. A single epibranchial spine present, sometimes obsolescent, especially in larger specimens. Front moderately broad, sinuously triangular, with a longitudinal depression. Orbits shallow, no supraocular spine, outer orbital angle not produced. Lateral walls complete, with some longitudinal ridges.

Eyes moderately large. First movable segment of antennae with serrated, lamellar lobe; second with large tubercle, third nearly smooth.

Chelipeds subequal, robust, surface rugose or granulate; merus rugose with serrated lobe on anterior margin; carpus two times as long as broad, covered with granules, anterior margin armed with three low, wide-set teeth, decreasing in size distally, posterior margin armed with a row of large, flattened granules, the distal two produced into spines; palm broad, covered with scattered granules, outer margin moderately convex.

Walking legs rugose, anterior margin fringed with feathered setae; anterior margin of merus spineless; a posterodistal spine on merus of legs 1 and 2; dactylus with three movable spinules on inner border.

**Habitat:** *P. lamarckii* occurs in the uppermost level of the intertidal, frequently under large, steady boulders.

**Distribution:** The species shows a large distributional range in the Indo-West Pacific, and has been recently reported from the Red Sea, with two females found by Werding and Hiller (2007) in an old collection by C.B. Klunzinger in 1877. While the specimens of Klunzinger were from El Quseir, we recently found several individuals near Dahab in the Gulf of Aquaba (Werding and Hahn, unpublished). However, a reliable distributional picture of the species cannot be confirmed before the *P. lamarckii* – complex is critically reviewed (see discussion below).

**Discussion:** When Kropp (1983) reviewed the *P. lamarckii* complex he created *P. borradailei* to receive specimens morphologically close to *P. lamarckii*, but distinguishable by the absence of epibranchial spines. This author described the presence of a “distinctive line of irregularly spaced, pale orange dots” in all *P. borradailei* specimens. We observed such an arrangement of orange dots in numerous specimens from the Red Sea (unpublished data), all showing well-formed epibranchial spines, thus clearly belonging to *P. lamarckii*. On the other hand, some specimens from Goa exhibit a row of irregular whitish or pale yellow dots, and in several individuals the epibranchial spines are

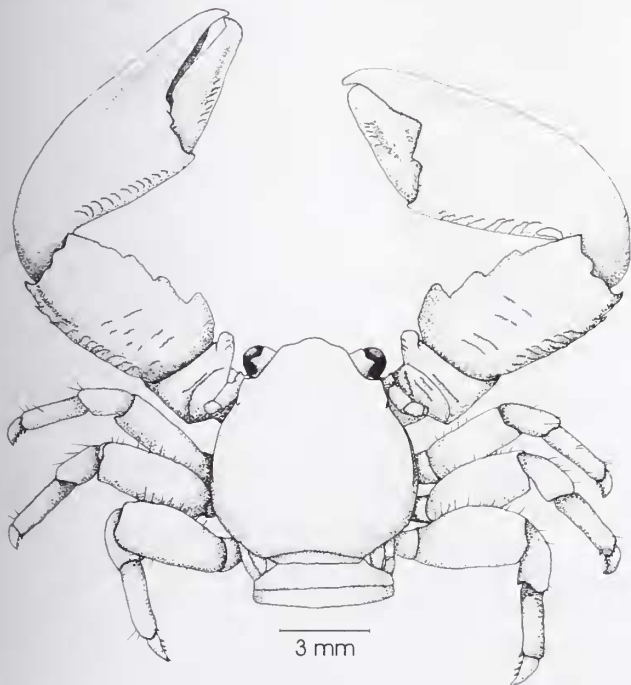


Fig. 6: *Petrolisthes lamarckii* (Leach, 1820, male, Indian Ocean, Kenya (from Werding & Hiller, 2007)

poorly defined or lacking. Thus, the presence or absence of epibranchial spines seems to be a variable character among populations or even within a local population. Consequently, the differences between *P. borradailei* and *P. lamarckii* are not clear and *P. borradailei* might be a junior synonym of *P. lamarckii*.

***Pisidia dehaanii* (Krauss, 1843) (Fig. 7)**

*Porcellana dehaanii*: Krauss, 1843: 59, pl.4 figs.2, 2a-c; Barnard, 1947: 378; Barnard, 1950: 467, figs.88 e-h; McNae & Kalk, 1958: 83, 126; Kensley, 1969: 153; Kensley, 1970: 105

*Pisidia dehaanii*: Haig, 1960: 209; Sankolli, 1965: 3; Sankolli, 1966: 305, fig.6; Haig, 1966c: 48; Sarojini & Nagabhushanan, 1968: 161, pl.II, fig.6; Mustaquim, 1972: 153, fig.1; Haig, 1978: 707; Lewinsohn, 1979: 52; Haig, 1981: 276; Tirmizi & Yaqoob, 1982: 15, fig.9, 27, pl.9; Hogarth, 1988: 1102; Tirmizi & Yaqoob, 1989: 27, figs.17, 18

**Material examined:** 1 ♂, 2 ♀ (ov.), Bogmolo Beach, under rocks, 0.5-1.0 m, low tide.

**Description:** Carapace about as long as broad, ovate. Dorsal surface rough, regions well-marked, with a pair of tufts formed by feathered setae on protogastric ridges, epibranchial edges pronounced, rounded, no epibranchial spine; two spines on branchial margin. Front with three prominent, rounded lobes, separated by deep clefts, median lobe considerably longer than lateral ones. Orbits shallow, outer orbital angle acuminate. Basal segment of antennulae with forwardly-directed, spine-tipped lobes; first and second movable segments of antennae finely granular, bearing one

or two small spines, flagellum about 1½ times as long as carapace.

Chelipeds different in size; merus with anterodistal, flattened trapezoid lobe; carpus about 2 times as long as broad, slightly rugose, anterior and posterior margin convex, dorsal surface with a shallow, longitudinal crest, larger chela broad, slightly rugose, outer margin convex; smaller cheliped similar with slightly concave outer margin.

Walking legs moderately long, slender, slightly rugose, with scattered setae; dactylus with three movable spinules on inner border.

**Habitat:** Haig (1981) referred to the ecology of the species as "intertidally among rocks and weeds". On the coast of Goa we only found scattered small specimens in interstices of stones and rubble agglomerated by sponges in the lower intertidal.

**Distribution:** *Pisidia dehaanii* is an endemic to the Indian Ocean, and was reported from the South African coast as far south as 32° S, northward from the Persian Gulf, and from both coasts of India.

***Pisidia gordonii* (Johnson, 1970) (Fig. 8)**

*Porcellana* (allied to *serratifrons*): Miers, 1884: 277

*Porcellana serratifrons*: Henderson, 1888: 110 (part); Grant & McCulloch, 1906: 39, 40; Nobili, 1906b: 75; Sankarankutty, 1963: 278, fig.3; McNeill, 1968: 34

*Porcellana spinulifrons*: Gordon, 1931: 530, figs.4C, 5

*Pisidia cf spinulifrons*: Haig, 1965: 105, 106

*Pisidia spinulifrons*: Sankolli, 1966: 307, fig.7

*Porcellana (Pisidia) gordonii*: Johnson, 1970: 29, fig.3

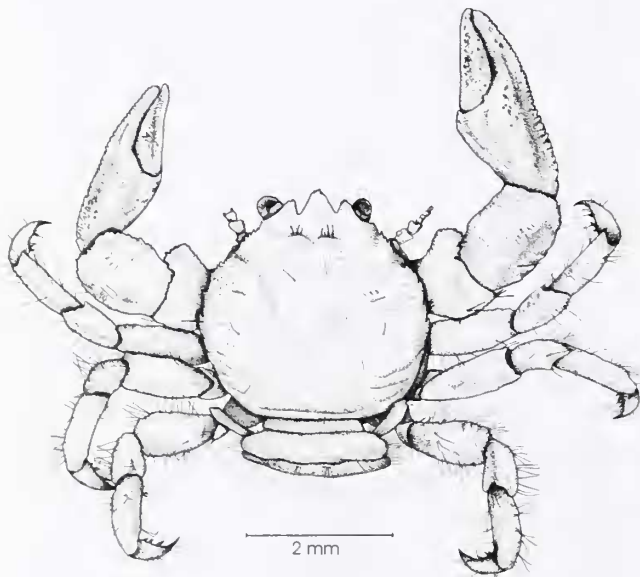


Fig. 7: *Pisidia dehaanii* (Kraus, 1843), male Bogmolo, St. George Island, Goa

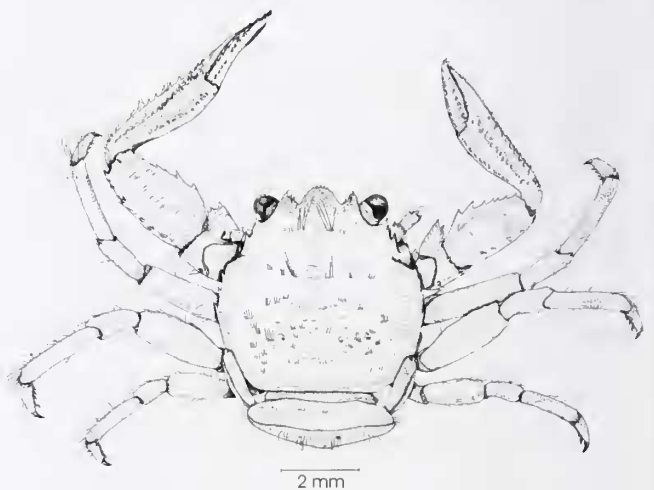


Fig. 8: *Pisidia gordonii* (Johnson, 1970), male Bogmolo, St. George Island, Goa

*Pisidia gordonii*: Haig, 1973: 283; Haig, 1978: 707; Haig, 1981: 277; Tirmizi *et al.*, 1989: 34, fig.21; Morgan, 1990: 32; Yang & Sun, 1990: 4, figs.5, 6; Haig, 1992: 318, fig.14; Komai, 2000: 366; Siddiqui & Kazmi, 2003: 88

**Material examined:** 6♂, 8♀, Bogmolo Beach, St. George Island, under rocks, 5 m, mid-low tide.

**Description:** Carapace slightly longer than broad, subovate. Dorsal surface rough, regions well-marked; epibranchial edges rounded, fringed with some smaller spinules; no prominent epibranchial spine. Front with three lobes, median lobe considerably broader than lateral ones, lateral lobes spine-tipped. Eyes large, orbits well-defined, outer orbital angle produced into a sharp spine, followed by another one of the same size. First and second movable segments of antennae finely granular, flagellum about 2 times as long as carapace.

Chelipeds slender, different in size, merus with spiny anterodistal projection, carpus more than two times as long as broad, slightly rugose, anterior margin convex, with irregular acute tooth; chelae with three longitudinal crest with rows of acute tubercles, except in larger cheliped of large animals.

Walking legs long and slender, slightly rugose, with scattered setae; dactylus with four movable spinules on inner border.

**Habitat:** Small specimens were found scattered in the lower intertidal, and large adults occurred regularly under stones in depths between 6-10 m. Haig (1966c) reported it at 50 m depth.

**Distribution:** The species is an endemic to the Indian Ocean and has been reported from Delagoa Bay, Mozambique, Madagascar and Pakistan. The findings from Goa are the first record from the Indian coast and represent a considerable range extension.

***Polyonyx hendersoni* Southwell, 1909 (Fig. 9)**

*Polyonyx hendersoni*: Southwell, 1909: 117, figs.6-9; Gravely, 1927: 141, pl.20 fig.11; Johnson, 1958: 98, 112; Haig, 1964: 380; Sankolli, 1966: 309, fig. 8; Tirmizi *et al.*, 1982: 3, fig.8, pl.VIII; Tirmizi *et al.*, 1989: 25, figs.15, 16

**Material examined:** 3♂, 2♀, Bogmolo Beach, 0.5-1.0 m, low tide, inside white sponge; 1♂, 1♀, Bogmolo Beach, St. George Island, 6 m, inside white sponge.

**Description:** Carapace rounded, nearly as broad as long, longitudinally convex. Dorsal surface smooth, except for some fine plications on branchial regions; epibranchial angles not produced, regions not defined. Front broad inclined, nearly straight from above. Orbits shallow, outer orbital angles insignificant. Lateral walls complete.

Eyes small, barely visible from above. First movable

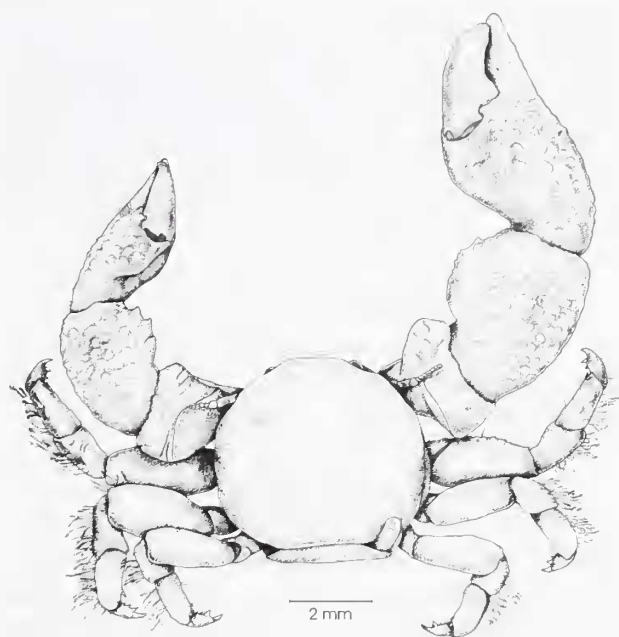


Fig. 9: *Polyonyx hendersoni* Southwell, 1909, male Bogmolo, St. George Island, Goa

segment of antenna subcylindric, short, second more than twice as long as broad, smooth, third smooth; flagellum 1½ times as long as carapace. Basal segment of antennules without prominence.

Chelipeds large, robust, different in size, irregularly covered with rounded, large granules; merus granulated, with some transverse ridges, anterodistal edge produced into large, rounded lobe; carpus 1½ times as long as broad, anterior border produced with three to five irregular tooth; fingers of manus of larger cheliped in large specimens gaping, fingers bent upwards, meeting for entire length in minor cheliped. Outer border of larger chela concave.

Walking legs smooth with long feathered setae on carpus, propodus and dactylus; dactylus with three strong, fixed spines.

**Habitat:** *P. hendersoni* seems to inhabit exclusively the water ducts of Demospongiae, inside which we found the species, from the intertidal to a depth of 6 m.

**Distribution:** The species has been reported from Pakistan, the western Indian coast to the south tip, eastward to the Gulf of Mannar, and from Sri Lanka.

**Remarks:** *Polyonyx hendersoni* belongs to a morphological group within the genus that is different from the *P. sinensis* - group (Johnson 1958), with species generally found within tubes of polychaete worms. Johnson (1958) stated that *P. hendersoni* did not seem to be closely related to any other species. He ascribed this species to the *P. biunguiculatus* group, highlighting that "its nearest affinities are apparently to *P. obesulus*". However, he

mentioned some differences between *P. hendersoni* and other species of *P. biunguiculatus* group, emphasizing on the different form of the meral lobe of the chelipeds, the armature of the chelipeds, the setation of the smaller cheliped, and the different form of the dactyli of the walking legs. *P. hendersoni* forms a clade together with *P. splendidus* Sankolli (see below), which also inhabits sponges.

***Polyonyx splendidus* Sankolli, 1963 (Fig. 10)**

*Polyonyx splendidus*: Sankolli, 1963b: 79, figs. 1a-i; Sankolli, 1966: 311, fig. 9

**Material examined:** 1 ♂, Bogmolo Beach, 0 m, low tide, in yellow sponge.

**Description:** Carapace rounded, nearly as broad as long, longitudinally convex. Dorsal surface with some granulation and plications more accentuated in branchial regions; epibranchial angles faintly produced, regions moderately marked. Front broad, somewhat produced beyond eyes, inclined, nearly straight from above or weakly trilobate. Orbits distinct, outer orbital angles insignificant. Lateral walls complete.

Eyes moderately large, visible from above. First movable segment of antenna subcylindric, short, second twice as long as broad, smooth, third smooth; flagellum 1½ times as long as carapace. Basal segment of antennules without protuberance.

Chelipeds large, robust, different in size, covered with scale-like granules, partly arranged in longitudinal ridges on carpus of larger chela; merus granulated, with some transverse ridges, anterodistal edge produced into a large, rounded lobe, spine tipped in some cases; carpus 1½ to 2 times as long as broad, anterior border produced,

with two or three spine-tipped teeth; fingers of manus in both chelipeds meeting in entire length, fingers bent upwards; outer border of larger chela straight or slightly concave; outer border and parts of upper surface of carpus and manus covered with dense, feathered setation.

Walking legs slender, smooth, with long-feathered setae on carpus, propodus and dactylus; dactylus with three strong, fixed spines.

**Habitat:** This species has been found by Sankolli (1966) in similar conditions as *P. hendersoni*, and was found by us inside a sponge. Despite intensive efforts to sample this species along the coast in the regions of Anjuna and Bogmolo, we found only one specimen in the duct of a sponge.

**Distribution:** The species is known only from the original description by Sankolli (1963b) and a later mention by the same author (Sankolli 1966). The former findings are from the coast near Ratnagiri (Maharashtra State), and the present finding extends its distribution southward to Bogmolo Beach, Goa.

**Remarks:** As mentioned above, *P. hendersoni* and *P. splendidus* seem to form a distinct clade within *Polyonyx*, which probably deserve their own generic status. The present findings of the two species living in sponges confirms our view that the body form and the form of the dactyli of the walking legs constitute adaptations to living in the water ducts of sponges (see discussion in Werding and Hiller 2004). The distribution of the two species seems to be restricted to the Indian subcontinent.

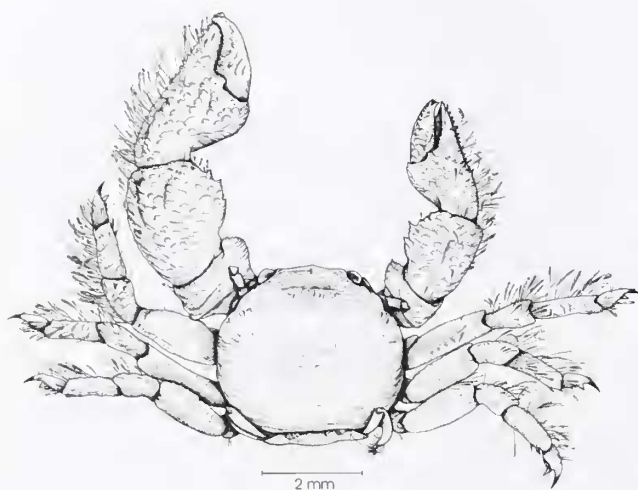


Fig. 10: *Polyonyx splendidus* Sankolli, 1963, male St. George Island, Goa,

**KEY TO THE SPECIES OF THE WESTERN COAST OF THE INDIAN SUBCONTINENT**

- 1 Chelipeds markedly different in size (heterochaely) ..... 2
- Chelipeds (sub) equal (isochaely) ..... 8
- 2 Front tridentate, lateral margins of carapace with spinules posterior to epibranchial angle ..... 3
- Front rounded, lateral margins of carapace spineless ..... 4
- 3 Median frontal lobe narrow, chelipeds stout, without acute spines on merus and carpus ..... *Pisidia dehaanii*
- Median frontal lobe broad, chelipeds slender, with acute spines on anterodistal edge of merus and anterior margin of carpus ..... *Pisidia gordonii*
- 4 Side walls of carapace divided in two parts ..... 5
- Side walls of carapace entire ..... 6
- 5 Carapace and chelipeds bare of setae ..... *Pachycheles natalensis*
- Carapace with dense setation on frontal region, chelipeds densely setose ..... *Pachycheles tomentosus*
- 6 Carapace subquadrate, broader than long, anterior margin of



- carpus of chelipeds entirely convex ..... *Polyonyx loimicola*
- Carapace subquadrate to subovate, as long as broad, carpus of chelipeds denticulated on anterior margin ..... 7
- 7 Both chelipeds covered with dense, feathered setation, anterior margin of carpus of chelipeds with 2-3 spine-tipped tooth ..... *Polyonyx splendidus*
- Chelipeds at most with short setation, anterior margin of carpus of chelipeds with blunt tooth .. *Polyonyx hendersoni*
- 8 Carpus of chelipeds with longitudinal crests on upper surface separated by deep grooves ..... 9
- Carpus of chelipeds without longitudinal crests and grooves (but sometimes with granules arranged in longitudinal rows) ..... 10
- 9 Lateral borders of carapace with a series of sharp spines ... ..... *Enosteoides ornatus*
- Lateral borders of carapace without spines ..... *Ancylocheles gravelei*
- 10 Surface of carapace and extremities with irregular, rounded granules, front trilobate, carpus of chelipeds with a blunt tooth on antero-proximal edge ..... *Petrolisthes ornatus*
- Surface of carapace and chelipeds smooth to rough or with piliferous striations, front sinuously triangular ..... 11
- 11 Manus of chelipeds with a longitudinal crest, walking legs with a row of spines on anterior margin of merus ..... *Petrolisthes coccineus*
- Manus of chelipeds evenly rounded, walking legs without spines on anterior margin of merus ..... 12
- 12 Carapace and chelipeds with piliferous striations on upper surface ..... *Petrolisthes boscii*
- Carapace and chelipeds without piliferous striations on upper surface ..... 13
- 13 Carapace with epibranchial spines ... *Petrolisthes lamarckii*
- Carapace without epibranchial spines ..... 14
- 14 Chelipeds massive, with three to four shallow tooth on anterior margin of carpus ..... *Petrolisthes rufescens*
- Chelipeds slender, with one proximal tooth on anterior margin of carpus, a second one present on half distance ..... *Petrolisthes leptocheles*

DISCUSSION

The porcellanid fauna of the western coast of the Indian subcontinent currently consists of 16 species (Table 1), 10 of which were sampled in the present study. A total of 9 species are endemic to the Indian Ocean, and 2 species, *Polyonyx hendersoni* and *P. splendidus*, seem to be endemic to the eastern Arabian Sea. Of special interest is an assemblage of 4 Indian Ocean endemics present on the coast of Pakistan, *Pachycheles tomentosus*, *Petrolisthes leptocheles*, *Petrolisthes ornatus* and *Petrolisthes rufescens* (the latter two also present on the coast of Kutch), which marks a faunistic break and the

Table 1: Porcellanid species reported from the western coast of the Indian subcontinent in the present study

Species	SAMP	NSAMP	EAS-END	IO-END	IWP
<i>Ancylocheles gravelei</i> (Sankolli 1963)	x			x	
<i>Enosteoides ornatus</i> (Stimpson 1858)	x			x	
<i>Pachycheles natalensis</i> (Krauss, 1843)	x			x	
<i>Petrolisthes boscii</i> (Audouin 1826)	x				x
<i>Petrolisthes coccineus</i> (Richardson <i>et al.</i> , 1839)	x				x
<i>Petrolisthes lamarckii</i> (Leach 1820)	x			x	x
<i>Pisidia dehaanii</i> (Krauss 1820)	x				
<i>Pisidia gordonii</i> (Johnson 1970)	x				x
<i>Polyonyx hendersoni</i> Southwell, 1909	x		x		
<i>Polyonyx splendidus</i> Sankolli, 1963	x		x		
<i>Pachycheles tomentosus</i> Henderson, 1893		x		x	
<i>Petrolisthes leptocheles</i> (Heller 1861)		x		x	
<i>Petrolisthes ornatus</i> Paulson 1875		x		x	
<i>Petrolisthes rufescens</i> (Heller 1861)		x		x	
<i>Pisidia delagoae</i> (Barnard 1955)		x		x	
<i>Polyonyx loimicola</i> Sankolli 1965		x			x

EAS: East Arabian Sea, IO: Indian Ocean, IWP: Indo-West Pacific.  
 END: Endemic species, SAMP: species sampled, NSAMP: not sampled

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## REFERENCES

- AHMED, M. & J. MUSTAQUIM (1974): Population structure of four species of porcellanid crabs (Decapoda, Anomura) occurring on the coast of Karachi. *Marine Biology* 26: 173-182.
- AUDOUIN, V. (1826): Explication sommaire des planches de Crustacés de l'Égypte et de la Syrie, publiées par Jules-Cesar Savigny, membre de l'Institut; Offrant un exposé des caractères naturels des genres avec la distinction des espèces. Description de l'Égypte, ou recueil des observations et des recherches que ont été faites en Égypte pendant l'expédition de l'armée française. *Histoire Naturelle* 1(4): 77-98.
- BALSS, H. (1913): Ostasiatische Decapoden. I. Die Galatheiden und Paguriden. *Königlich-Bayrische Akademie der Wissenschaften. Abhandlungen der Mathematisch-naturwissenschaftlichen Klasse*, Supplement 2: 1-85.
- BALSS, H. (1915): Anomuren, Dromiaceen und Oxystomen. Die Decapoden des Roten Meeres II. Expeditionen S.M. Schiff "Pola" in das Rote Meer, nördliche und südliche Hälfte. *Zoologische Ergebnisse XXXI. Denkschriften / Akademie der Wissenschaften in Wien, Mathematisch-Naturwissenschaftliche Klasse* 92: 1-20, fig. 1-9.
- BARNARD, K.H. (1947): Descriptions of new species of South African Decapod Crustacea, with notes on synonymy and new records. *Annals and Magazine of Natural History* (11)13: 361-392.
- BARNARD, K.H. (1950): Descriptive catalogue of South African decapod Crustacea (crabs and shrimps). *Annals of the South African Museum* 38: 471-481.
- BARNARD, K.H. (1955): Additions to the fauna-list of South African Crustacea and Pycnogonida. *Annals of the South African Museum* 43(1): 1-107.
- BORRADAILE, L.A. (1898): On some crustaceans from the South Pacific. Part II. Macrura Anomura. *Proceedings of the Zoological Society of London* 3: 457-468.
- DANA, J.D. (1852-53): Crustacea. United States Exploring Expedition during the years 1838, 1839, 1840, 1841, 1842, under the command of Charles Wilkes. *U.S.N. 13*: viii + 1-685 (1852), 686-1618 (1853). C. Sherman, Philadelphia.
- DANA, J.D. (1855): Crustacea. United States Exploring Expedition during the years 1838, 1839, 1840, 1841, 1842, under the command of Charles Wilkes. *U.S.N. Ibid* 14: 1-27, Philadelphia.
- DOFLEIN, F. & H. BALSS (1913): Die Galatheiden der Deutschen Tiefsee-Expedition. *Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition auf dem Dampfer "Valdivia" 1898-1899*, 20, 125-184.
- GORDON, I. (1931): Brachyura from the coasts of China. *Journal of the Linnean Society of London, Zoology* 37: 525-558.
- GRANT, F.E. & A.R. McCULLOCH (1906): On a collection of crustaceans from the Port Curtis district, Queensland. *Proceedings of the Linnean Society of NSW* 31: 2-53.
- GRAVELY, F.H. (1927): Orders Decapoda (except Paguridea) and Stomatopoda. In: The littoral fauna of Krusadai Island in the Gulf of Manaar. *Bulletin, Madras Government Museum* 1(1): 135-155.
- HAIG, J. (1960): The Porcellanidae (Crustacea Anomura) of the eastern Pacific. Allan Hancock Pacific Expeditions, 24, 440 pp.
- HAIG, J. (1964): Papers from Dr. Th. Mortensen Pacific expedition 1914-1916. 81. Porcellanid crabs from the Indo-West Pacific, Part I. *Videnskabelige Meddelelser fra Dansk Naturhistorisk Foren* 126: 355-386.
- HAIG, J. (1965): The Porcellanidae (Crustacea, Anomura) of Western Australia with descriptions of four new Australian species. *Journal of the Royal Society of Western Australia* 48(4): 97-118.
- HAIG, J. (1966a): A review of the Indo-West Pacific species of genus *Pachycheles* (Porcellanidae, Anomura). *Proceeding Symposium of Crustacea, India* 1: 285-294.
- HAIG, J. (1966b): Sur une collection de crustacés porcellanes (Anomura: Porcellanidae) de Madagascar et des Comores. *Cahiers Orstom Océanographie* 3(4): 39-50.
- HAIG, J. (1966c): The Porcellanidae (Crustacea Anomura) of the Iranian Gulf and Gulf of Oman. *Videnskabelige Meddelelser fra Dansk Naturhistorisk Forening* 129: 49-65.
- HAIG, J. (1972): The anomuran crabs of Western Australia: Their distribution in the Indian Ocean and adjacent Seas. *Journal of the Marine Biological Association India* 14(2): 443-451.
- HAIG, J. (1973): Galatheidea (Crustacea, Decapoda, Anomura) collected by the F.I.S. Endeavour. *Records of the Australian Museum* 28: 269-289.
- HAIG, J. (1978): Contribution toward a revision of the porcellanid genus *Porcellana* (Crustacea: Decapoda: Anomura). *Proceedings of the Biological Society of Washington* 91(3): 706-714.
- HAIG, J. (1979): Expédition Rumphius II (1975) Crustacés parasites, commensaux, etc. (Th. Monod et R. Werene, éd.) V. Porcellanidae (Crustacea, Decapoda, Anomura). *Bulletin du Muséum national d'Histoire naturelle, Paris*, 4 Serie, 1, Section 1(1): 119-136.
- HAIG, J. (1981): Porcellanid crabs from the Indo-West Pacific, Part II. *Steenstrupia* 7(12): 269-291.
- HAIG, J. (1983): Porcellanidae (Decapoda, Anomura) from the Seychelles, Western Indian Ocean. *Crustaceana* 45(3): 279-289.
- HAIG, J. (1992): Hong Kong's Porcellanid Crabs. In: Morton, B. (Ed.): The marine flora and fauna of Hong Kong and southern China III. Proceedings of the Fourth International Marine Biological Workshop: The marine flora and fauna of Hong Kong and Southern China; Hong Kong, 11-29 April 1989. Hong Kong University Press. Pp. 303-327.
- HALE, H.M. (1929): Crustacea. Notes on the Fauna of Dirk Hartog Island, Western Australia. No. 4. *Transactions of the Royal Society, South Australia* 53: 67-70.
- HASWELL, W.A. (1882): Description of some new species of Australian Decapoda. *Proceedings of the Linnean Society of New South Wales* 6: 750-763.
- HELLER, C. (1861a): Synopsis der im rothen Meere vorkommenden Crustaceen. *Verhandlungen der Zoologisch-botanischen Gesellschaft in Wien* 11: 3-32.

- HELLER, C. (1861b): Beiträge zur Crustaceen-Fauna des rothen Meeres. Zweiter Theil. *Sitzungsberichte der Akademie der Wissenschaften zu Wien*, Mathematisch-naturwissenschaftliche Klasse 44: 241-295.
- HELLER, C. (1865): Crustaceen. In: *Reise der oesterreichischen Fregatte "Novarra" um die Erde, in den Jahren 1857, 1858, 1859, unter den Befehlen des Commodore B. von Wullerstorf-Ubair*. Zoologischer Theil, 2(3). Vienna. 280 pp.
- HENDERSON, M.B. (1893): A contribution to Indian carcinology. Part X. *Transactions of the Linnean Society London* 2(5): 325-431.
- HENDERSON, J.R. (1888): Report on the Anomura collected by H.M.S. Challenger during the Years 1873-76. *Rep. Zool. Challenger Expedition*, 27: xi + 221.
- HOGARTH, P.J. (1988): Anomuran Crustacea (Paguridae, Porcellanidae, and Hippidae) from Oman, principally from Dhofar province, southern Oman. *Journal of Natural History* 22: 1095-1110.
- HSIEH, B.F., T.Y. CHAN & H.P. YU (1998): On the Porcellanid Crabs (Crustacea: Decapoda: Porcellanidae) of Taiwan. *Annual of Taiwan Museum* 40: 276-360.
- JOHNSON, D.S. (1958): The Indo-West Pacific species of the genus *Polyonyx* (Crustacea, Decapoda, Porcellanidae). *The Annals of Zoology, Academy of Zoology II* (8): 95-118.
- JOHNSON, D.S. (1970): The Galatheidea (Crustacea: Decapoda) of Singapore and adjacent Waters. *Bulletin of the national Museum Singapore* 35(1): 1-43.
- KENSLEY, B. (1969): Decapod Crustacea from the south-west Indian Ocean. *Annals of the South African Museum* 52: 149-181.
- KENSLEY, B. (1970): A small collection of decapod crustacea from Mocabique. *Annals of the South African Museum* 57: 103-122.
- KIM, H.S. & B.L. CHOE (1968): Addition of three anomuran species to the fauna of Korea. *Reports from the Institute of Marine Biology, Seoul National University* 2: 1-9.
- KOMAI, T. (2000): A checklist of Thalassinidae and Anomura (Crustacea: Decapoda) from The South China Sea. *The Raffles Bulletin of Zoology*, Suppl. 8: 343-376.
- KRAUSS, F. (1843): *Die südafrikanischen Crustaceen. Eine Zusammenstellung aller bekanten Malacostraca, Bemerkungen über deren Lebensweise und geographische Verbreitung, nebst Beschreibung und Abbildung mehrerer neuer Arten*. E. Schweizerbart, Stuttgart. 68 pp.
- KROPP, R.K. (1983): Three new species of Porcellanidae (Crustacea: Anomura) from the Mariana Islands and a discussion of Borradaile's *Petrolisthes lamarckii* complex. *Micronesia* 19(1-2): 91-106.
- LAURIE, R.D. (1926): No. VI. - Anomura collected by Mr. J. Stanley Gardiner in the Western Indian Ocean in H.M.S. "Sealark". *Transactions of the Linnean Society London (Zool.)* 19: 121-167.
- LEACH, W.E. (1820): Galatédées. *Dictionnaire des Sciences Naturelles* 18: 49-56.
- LEWINSOHN, C. (1969): Die Anomuren des Roten Meeres (Crustacea Decapoda: Paguridae, Galatheidea, Hippidea). *Zoologische Verhandlungen* 104: 1-210.
- LEWINSOHN, C. (1979): Researches on the coast of Somalia. The shore and the Dune of Sar Uanle. 23. Porcellanidae (Crustacea Decapoda Anomura). *Italian Journal of Zoology*, Supplemento XII: 39-57.
- MAN, J.G. DE (1888): Bericht über die von Herrn Dr. Brock im indischen Archipel gesammelten Decapoden und Stomatopoden. *Archiv für Naturgeschichte Berlin* 53(1): 215-600.
- MAN, J.G. DE (1893): Report on the podopththalmous Crustacea, collected in the year 1891 by Dr. H. Ten Kate in some Islands of the Malay Archipelago. *Notes Leyden Museum* 15: 284-311.
- MACNÆ, W. & M. KALK (1958): A natural history of Inhaca Island, Mocabique. Witwatersrand University Press, Johannesburg, 163 pp.
- MARKHAM, J.C. (1982): Bopyrid isopods parasitic on decapod crustaceans in Hong Kong and southern China. Pp. 325-391. In: Morton, B. & C.K. Tseng (Eds): The marine flora and fauna of Hong Kong and southern China. *Proceedings of the First International Marine Biological Workshop: The marine flora and fauna of Hong Kong and Southern China*; Hong Kong, April 18 - May 10, 1980. Hong Kong University Press.
- MCCULLOCH, A.R. (1913): Studies in Australian Crustacea. No. 3. *Records of the Australian Museum* 9: 321-353.
- MCNEILL, F.A. (1968): Great Barrier Reef Expedition 1928-29. Crustacea, Decapoda & Stomatopoda. Trustees of the British Museum (Natural History), London. *Scientific Reports* 7(1): 1-98.
- MIERS, E.J. (1884): Collections from Melanesia. Crustacea. In: Report on the Zoological Collections made in the Indo-Pacific Ocean during the voyage of H.M.S. 'Alert' 1881-2, British Museum London. Pp. 178-322.
- MILNE EDWARDS, H. (1837): *Histoire naturelle des Crustacés, comprenant l'anatomie, la physiologie et la classification de ces animaux*, 2, Paris. 531 pp.
- MIYAKE, S. (1937): Porcellanids from Tanabe Bay. *Annotationes Zoologicae Japonensis*, 16(3): 210-216.
- MIYAKE, S. (1942): Studies on the decapod crustaceans of Micronesia. III. Porcellanidae. *Palao Tropical Biological Station Studies II* (3): 329-379.
- MIYAKE, S. (1943): Studies on the crab-shaped anomura of Nippon and adjacent waters. *Journal of the Department of Agriculture, Kyusyu Imperial University* 7(3): 49-158.
- MIYAKE, S. (1961): Three new species of the Anomura from Japan (Crustacea, Decapoda). *Journal of the Department of Agriculture, Kyusyu Imperial University* 11(3): 237-247.
- MIYAKE, S. & Y. NAKASONE (1943): On two species of the genus *Petrolisthes* (Anomura, Porcellanidae) from Japan. *Journal of the Faculty of Agriculture, Kyushu University* 14(1): 173-182.
- MORGAN, G.J. (1990): A collection of Thalassinidea, Anomura and Brachyura (Crustacea: Decapoda) from the Kimberley region of northwestern Australia. *Zoologische Verhandlungen*, 265, 1-90.
- MORTON, B. & J. MORTON (1983): The seashore ecology of Hong Kong. *Hong Kong University Press*. 350 pp.
- MUSTAQUIM, J. (1972): Species of porcellanid crabs from Karachi. *Pakistan Journal of Zoology* 4(2): 153-159.
- NAKASONE, Y. & S. MIYAKE (1971): Porcellanid crabs (Anomura: Porcellanidae) from New Caledonia and the Fiji Islands. *Biological Magazine Okinawa* 8: 1-13.
- NOBILI, G. (1906a): Faune carcinologique de la Mer Rouge. Décapodes et Stomatopodes. *Annales des Sciences Naturelles (Zoologie)* (9)4: 1-347.
- NOBILI, G. (1906b): Mission J. Bonnier et Ch. Pérez. (Golfe Persique, 1901). Crustacés décapodes et Stomatopodes. *Bulletin Scientifique de la France et de la Belgique* 40: 13-159.
- ORTMANN, A.E. (1894): Zoologische Forschungsreisen in Australien und dem Malayischen Archipel ausgeführt in den Jahren 1891-1893 von Dr. Richard Semon. Fünfter Band: Systematik und Tiergeographie. 1. Lieferung. Crustaceen. *Denkschriften der medizinisch-naturwissenschaftlichen Gesellschaft zu Jena* 8: 3-80.
- ORTMANN, A.E. (1897): Carcinologische Studien. *Zoologische Jahrbücher, Abt. für Systematik, Geographie und Biologie der Thiere* 10: 273-297.
- RICHARDSON, J., N.A. VIGORS, G.T. LAY, E.T. BENNETT, R. OWEN, J.E. GRAY, W. BURKLAND & G.B. SOWERBY (1839): The zoology of Captain Beechey's voyage; compiled from the collections and notes made by Captain Beechey, the officers and naturalist of the expedition, during a voyage to the Pacific and Behring's

- Straits performed on His Majesty's Ship Blossom under the command of Captain F.W. Beechey, R.N., F.R.S., in the years 1825, 26, 27 and 28.: i-xii, 1-180.
- PAUL'SON, O. (1875): *Isledovaniya rakoobraznykh krasnago morya s zametkami otnositel'no rakoobraznykh drugikh morei*, xiv + 144 pp. (1961, English translation, 164 pp.).
- RAMADAN, M.M. (1936): Report on a collection of Stomatopoda and Decapoda from Ghardaqa, Red Sea. *Bulletin of the Faculty of Science, Egyptian (Fouad I) University* 6: 1-43.
- RATHBUN, M.J. (1910): Decapod crustaceans collected in Dutch East India and elsewhere by Mr. Thomas Barbour in 1906-1907. *Bulletin of the Museum of Comparative Zoology* 52: 305-317.
- RIDDELL, W. (1911): The Anomura. Reports on the Marine Biology of the Sudanese Red Sea, from collections made by Cyril Crossland. XVII. *Journal of the Linnean Society London. (Zool.)* 31: 260-264.
- SANKARANKUTTY, C. (1963): On three species of porcellanida (Crustacea, Anomura) from the Gulf of Mannar. *Journal of the Marine Biological Association India* 5(2): 273-279.
- SANKOLLI, K.N. (1963a): On a new species of porcellanid crab (Decapoda, Anomura) from India. *Journal of the Marine Biological Association India* 5(2): 280-283.
- SANKOLLI, K.N. (1963b): On a new species of porcellanid crab (Decapoda, Anomura) from India. *Journal of the Zoological Society of India* 15(1): 79-84.
- SANKOLLI, K.N. (1965): On the Porcellanidae (Crustacea, Anomura) of Ratnagiri. *Symposium on Crustacea, Marine Biol. Ass. India. Abstracts of Papers: 3*
- SANKOLLI, K.N. (1966): On the Porcellanidae (Crustacea, Anomura) of Ratnagiri along the west coast of India. *Proceedings of the Symposium of Crustacea, Cochin I*: 295-313.
- SAROJINI, R. & R. NAGABHUSHANAM (1968): Notes on porcellanid crabs (Crustacea, Anomura) from Waltair Coast. *Journal of the Zoological Society India* 20(1&2): 149-163.
- SIDDIQUI, F.A. & Q.B. KAZMI (2003): A checklist of marine anomurans (Crustacea: Decapoda) of Pakistan, northern Arabian Sea. *Memoirs of Museum Victoria* 60(1): 87-89.
- SOUTHWELL, T. (1909): Report on the Anomura collected by Mr. James Hornell at Okhamandal in Kattiawar in 1905-06. Pp. 105-123. In: Hornell, J. (Ed.): *Report to the Government of Baroda on the marine ecology of Okhamandal in Kattiawar*. Part I. London.
- STIMPSON, W. (1858): *Prodromus descriptionis animalium vertebratorum, quae in Expeditione ad Oceanum Pacificum Septentrionalem, a Republica Federata miss, Cadwaladaro Ringgold et Johanne Rodgers Ducibus, observavit et descripsit. Pars VII. Crustacea Anomura. Proceedings of the Academy of Natural Sciences Philadelphia* 10: 225-252.
- STIMPSON, W. (1907): Report on the Crustacea (Brachyura and Anomura) collected by the North Pacific exploring expedition, 1853-1856. *Smithsonian Miscellaneous Collections* 49(3): 5-240.
- TAYLOR, J.D. (1968): Coral reef and associated invertebrate communities (mainly molluscan) around Mahé, Seychelles. *Philosophical Transactions of the Royal Society of London (B)* 254: 129-206.
- TIRMIZI, N.M., M. YAQOOB & F.A. SIDDIQUI (1982): An illustrated key to the identification of anomurans (Porcellanidae, Albuneidae and Hippidae) of the northern Arabian Sea. *Centre of Excellence, Marine Biology, University of Karachi, Pakistan* 2: 1-29.
- TIRMIZI, N.M., M. YAQOOB & F.A. SIDDIQUI (1989): Marine fauna of Pakistan: 3 Porcellanid crabs (Crustacea, Anomura). *Centre of Excellence, Marine Biology, University of Karachi, Pakistan* 6: 1-46.
- VATOVA, A. (1943): I Decapodi della Somalia. *Thalassia* 6(2): 1-37.
- WARD, M. (1942): Notes on the Crustacea of the Desjardins Museum, Mauritius Institute with descriptions of new genera and species. *Mauritius Institute Bulletin* 2(2): 49-109.
- WERDING, B. & A. HILLER (2004): Description of a new species of *Petrolisthes* from the western Pacific (Decapoda, Anomura, Porcellanidae). *Crustaceana* 77: 257-264.
- WERDING, B. & A. HILLER (2007): The Porcellanidae (Crustacea: Decapoda: Anomura) of the Red Sea with description of a new species of *Petrolisthes*. *Zootaxa* 1460: 1-24.
- WHITE, A. (1847): List of the specimens of Crustacea in the collection of the British Museum, London: 1-143.
- YANG, S.L. (1983): Preliminary report on the Porcellanidae (Crustacea, Anomura) of Xisha Island, Guangdong Province, China. *Memoirs of Beijing Natural History Museum* 24: 1-9.
- YANG, S.L. & Z.X. SUN (1990): On the porcellanid crabs from the coast of Fujian Province, China. *Beijing Natural History Museum* 45: 1-15.
- YANG, S.L. & Z.X. SUN (1992): On the porcellanid crabs (Anomura: Porcellanidae) of Guanxi Province, China. *Transactions of the Chinese Crustacean Society* 3: 196-213.
- YANG, S.L. & P. NAIYANETR (1997): Thailand's Porcellanid Crabs (Crustacea: Decapoda: Anomura). *Memoirs of Beijing Natural History Museum* 56: 1-13.

